

(12) UK Patent Application (19) GB (11) 2 309 466 (13) A

(43) Date of A Publication 30.07.1997

(21) Application No 9601725.6

(22) Date of Filing 29.01.1996

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(51) INT CL⁶

D04H 1/44 1/46

(52) UK CL (Edition O)

D1R RFH R151 R307 R541

(56) Documents Cited

EP 0333228 A2

EP 0321237 A2

EP 0303528 A1

US 2862251 A

(58) Field of Search

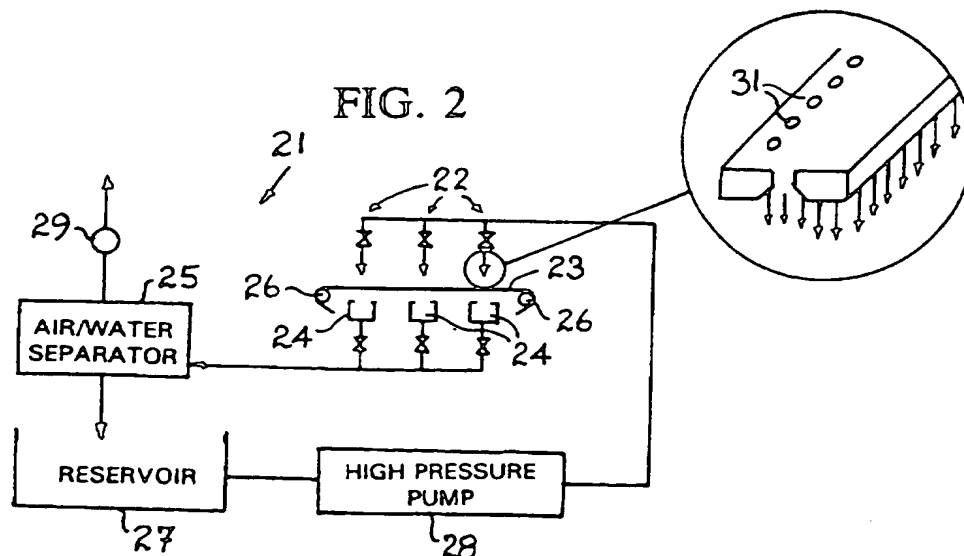
UK CL (Edition O) D1R RFH RFZ RGH RGZ

INT CL⁶ D04H 1/44 1/46

Online: WPI

(54) A nonwoven cellulose fabric

(57) A hydroentangled nonwoven fabric comprising entangled manmade cellulose fibres such as lyocell or viscose bonded together by their entanglement, the fabric having a tenacity when the fabric is wet which is greater than when the fabric is dry. The invention also relates to a method of manufacturing such a fabric in which a web of regenerated staple cellulose fibres on a conveyor (23) is passed under high pressure water jets (22).



GB 2 309 466 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG. 1

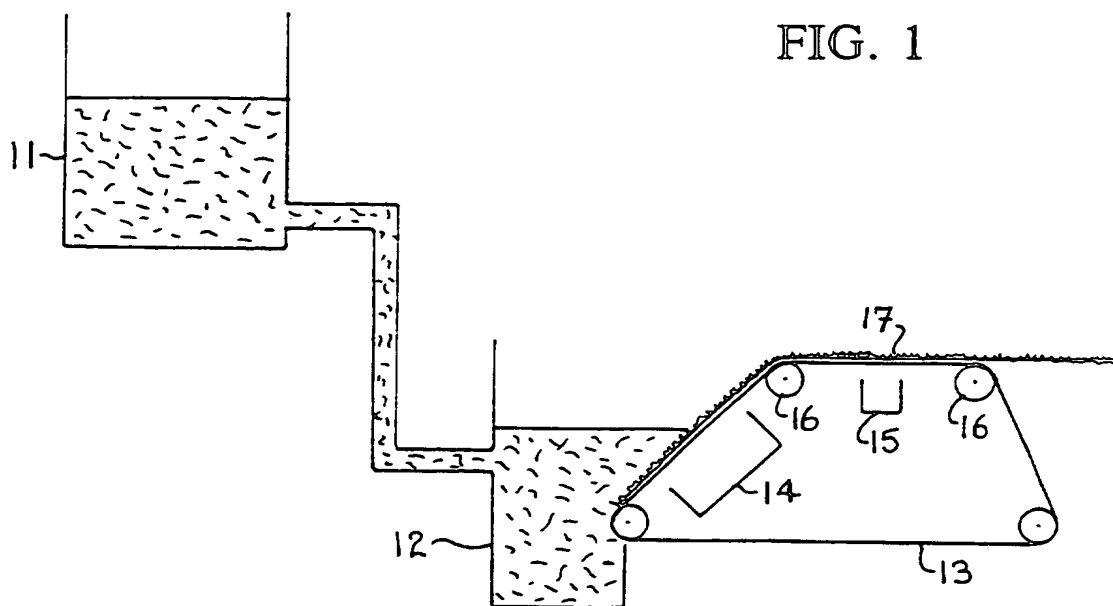
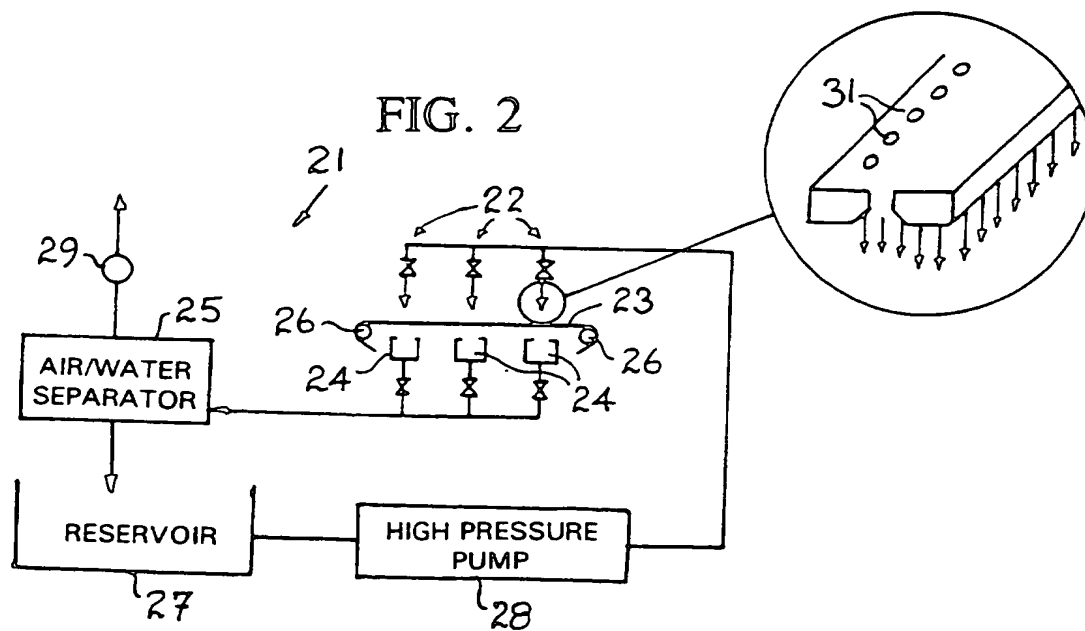


FIG. 2



A Nonwoven Fabric

This invention relates to a hydroentangled nonwoven fabric and to a method of manufacturing such a fabric.

Nonwoven fabrics made by subjecting a web of discontinuous
5 fibres to the action of high pressure water jets are known and typical hydroentanglement techniques are described in US-A-3,485,706 and US-A-3,508,308.

Known nonwoven fabrics produced by the hydroentanglement process generally have an adequate dry strength for their
10 intended end use. However the strength of such fabrics tends to fall away when the fabrics become wet. The problem relating to the wet strength of nonwoven fabrics, particularly those based on cellulose, has conventionally been solved by the use of resin binders to promote inter
15 fibre bonding. Nonwoven fabrics are typically bonded by acrylic latexes, or thermally bonded by adding a thermally bonded fibre, e.g. polypropylene.

For certain nonwoven fabric products, in particular products such as paper towels, protective garments or medical or
20 surgical materials having medical applications or requiring good absorbency, the presence of additional binders to improve the wet strength of the fabric may be undesirable since it could affect the medical and absorbency characteristics of the material.

An aim of the present invention is to provide a nonwoven fabric having an improved wet strength.

According to one aspect of the present invention there is provided a hydroentangled nonwoven fabric comprising
5 entangled man-made cellulose fibres bound together solely by their entanglement, the fabric having a tenacity when wet which is greater than its tenacity when dry.

The relative wet and dry strengths of a fabric according to the invention is contrary to the relative wet and dry
10 strengths of the cellulose fibres from which the fabric is made. In particular, known man-made cellulose fibres, such as rayon, lyocell and viscose fibres, typically have a tensile strength which is lower when wet than when dry.

Preferably the fibres are staple fibres having a length of
15 between 5 and 6 mm. If the fibres are formed from lyocell, that is cellulose reconstituted from a solution of cellulose in amine oxide, the fibres will preferably have a decitex of between 0.1 and 1.7 decitex.

If the fibres are formed by the viscose process, the
20 preferred decitex of the fibres does not exceed 4.0 decitex, and preferably lies between 1.6 and 4.0 decitex.

According to another aspect of the present invention, a method of manufacturing a fabric according to said one

aspect comprises passing a web of regenerated cellulose staple fibres, preferably each having a length of from 5 to 6 mm, on a belt under at least one high pressure water jet assembly arranged transversely of the belt, the or at least one of the water jet assemblies have an operating pressure of between 75 and 200 bar.

Preferably at least the final jet assembly has an operating pressure of about 100 bar.

The web of reconstituted cellulose fibre is prepared by a wet lay process and has an areal density of from 50 to 200 gm² and preferably of from 60 to 80 gm².

An embodiment of the invention will now be described, by way of example only, with particular reference to the accompanying drawing, in which:-

Figure 1 is a schematic diagram of an apparatus for forming a wet-laid web of fibres which can subsequently be hydroentangled to form a nonwoven fabric according to the present invention; and

Figure 2 is a schematic diagram of a hydroentanglement apparatus of the type used to form a nonwoven fabric according to the present invention.

Figure 1 shows in schematic form a Pilot Scale Neue Breuderhaus inclined wire wet lay system for forming a wet-laid web of fibres. In a first stage, the wet-laid web is manufactured by dispersing short cut or staple fibres in water to form a strong slurry in tank 11. The slurry is fed into a reservoir 12 where it is deposited onto an endless mesh conveyor belt 13 which passes around guide rollers 16 and interfaces with a portion of the reservoir 12. Water is removed by vacuum boxes 14 and 15 which suck water through the belt 13 to leave a web 17 of deposited fibres on the belt 13.

The web 17 is then either rolled onto a storage roller for further treatment at a different site or at a different time, or fed directly into an apparatus for manufacture of a nonwoven fabric.

In the second stage of the process, the wet-laid web 17 is fed into the hydroentanglement apparatus 21 shown schematically in Figure 2. The apparatus 21 comprises a porous mesh endless conveyor belt 23 passing around guide rollers 26. The belt has a mesh size of 100 mesh and a width of about 30 cm. Three sets of jet head assemblies 22 are spaced along the horizontal portion of the conveyor belt 23 at intervals of from 20 to 25 cm and extend transversely thereto.

Vacuum boxes 24 are arranged beneath the horizontal portion

of the conveyor belt 23 in alignment with the jet head assemblies 22 to remove water from the conveyor through the mesh belt. The water is removed from the conveyor 23 by a vacuum pump 29 acting through an air/water separator 25 which passes the recovered water to a reservoir 27. The recovered water is fed from the reservoir 27 back to the jet head assemblies 22 via a high pressure pump 28.

The jets 31 of the jet head assemblies 22 are arranged 12.5 mm above the conveyor belt 23. The jets 31 are 120 microns in diameter and are arranged as a single row of holes extending across the conveyor, the holes being spaced at a hole density of 40 holes per inch wide (16 holes per cm).

The entangled web 17 from the first stage is put onto the conveyor belt 23 and passes under the jet assemblies 22 at a speed of between 2 and 7 m per minute. Water is jetted out of two neighbouring assemblies of the three jet assemblies 22. The web 17 makes four passes through the hydro-entanglement machine, with one side of the web being exposed to the jets on passes 1 and 3 and the other side being exposed to the jets on passes 2 and 4.

Different fabric test samples were prepared to illustrate the invention. In all cases, in the first stage of the process, 75 g of dry weight fibres were dispersed in 300 l of water to give a 0.25% consistency suspension which was then agitated for 4½ minutes. The dispersed suspension was

laid onto the endless belt, moving at a speed of 0.35 ms^{-1} to lay a web of approximately 80 gm^2 . In the second stage of the process, the jet head pressures and conveyor speeds for manufacturing the different test samples were as follows:-

5

Sample 1

| | Jet 1 | Jet 2 | Conveyor Speed |
|-----------|--------|--------|----------------|
| Pass 1 | 40 bar | 40 bar | 2.5 m/min |
| Pass 2 | 40 bar | 50 bar | 6.5 m/min |
| Pass 3 | 50 bar | 50 bar | 6.5 m/min |
| 10 Pass 4 | 50 bar | 50 bar | 2.5 m/min |

Sample 2

| | Jet 1 | Jet 2 | Conveyor Speed |
|-----------|--------|--------|----------------|
| Pass 1 | 40 bar | 40 bar | 2.5 m/min |
| Pass 2 | 40 bar | 60 bar | 6.5 m/min |
| 15 Pass 3 | 60 bar | 60 bar | 6.5 m/min |
| Pass 4 | 60 bar | 75 bar | 2.5 m/min |

Samples 3-6

| | Jet 1 | Jet 2 | Conveyor Speed |
|-----------|---------|---------|----------------|
| Pass 1 | 40 bar | 40 bar | 2.5 m/min |
| 20 Pass 2 | 60 bar | 60 bar | 6.5 m/min |
| Pass 3 | 80 bar | 80 bar | 6.5 m/min |
| Pass 4 | 100 bar | 100 bar | 2.5 m/min |

Fibre Tenacity

The tenacities of the fibres used in the tests were as follows:-

25

| | Dry Tenacity | Wet Tenacity |
|------------------|--------------|--------------|
| Lyocell 1.7 dtex | 41.8 cN/tex | 33.5 cN/tex |
| Lyocell 1.4 dtex | 45 cN/tex | 37.9 cN/tex |
| Viscose 1.7 dtex | 22 cN/tex | 12 cN/tex |

- 5 It can be seen that for each fibre the wet strength is lower than the dry strength.

Tests

The hydroentangled fabrics manufactured from various staple fibres were tested for wet and dry tensile properties in the machine direction (MD) and cross direction (CD) according to BSEN 29073-3 (1992). The results are presented so that the dry results have a rating of 100, and the wet results have a relative rating. The samples referred to below are for different machine runs.

- 15 Generally, although all the results have been standardised to emphasise the changes in tensile properties between wet and dry fabrics, the fabric wet and dry strengths increase with increasing hydroentanglement maximum pressures (pass 4) between 50 and 100 bar and the fabric strength increases with increasing staple fibre lengths from 5 mm up to 12 mm. For a given length of fibre, e.g. 5 mm, a decrease in decitex of the fibre say from 1.7 to 1.4, is generally accompanied by an increase in fabric strength.

Sample 1

| | | Tenacity | | | |
|------------|-----------------------|----------|-----|-----|-----|
| Fibre Type | | MD | MD | CD | CD |
| | | Dry | Wet | Dry | Wet |
| 5 | 1.7 d.tex lyocell 5mm | 100 | 71 | 100 | 93 |
| | 1.4 d.tex lyocell 5mm | 100 | 85 | 100 | 83 |
| | 1.7 d.tex viscose 5mm | 100 | 130 | 100 | 51 |

Sample 2

| | | Tenacity | | | |
|------------|-----------------------|----------|-----|-----|-----|
| Fibre Type | | MD | MD | CD | CD |
| | | Dry | Wet | Dry | Wet |
| 10 | 1.7 d.tex lyocell 5mm | 100 | 82 | 100 | 81 |
| | 1.4 d.tex lyocell 5mm | 100 | 104 | 100 | 77 |
| | 1.7 d.tex viscose 5mm | 100 | 181 | 100 | 240 |

15

Sample 3

| | | Tenacity | | | |
|------------|-----------------------|----------|-----|-----|-----|
| Fibre Type | | MD | MD | CD | CD |
| | | Dry | Wet | Dry | Wet |
| | 1.7 d.tex lyocell 5mm | 100 | 105 | 100 | 104 |
| 20 | 1.4 d.tex lyocell 5mm | 100 | 157 | 100 | 152 |
| | 1.7 d.tex viscose 5mm | 100 | 104 | 100 | 135 |

Sample 4

| | | Tenacity | | | |
|------------|------------------------|----------|-----|-----|-----|
| Fibre Type | | MD | MD | CD | CD |
| | | Dry | Wet | Dry | Wet |
| 25 | 1.7 d.tex lyocell 5mm | 100 | 103 | 100 | 87 |
| | 1.4 d.tex lyocell 5mm | 100 | 130 | 100 | 128 |
| | 1.7 d.tex viscose 5mm | 100 | 103 | 100 | 87 |
| | 1.7 d.tex lyocell 8mm | 100 | 73 | 100 | 70 |
| 30 | 1.7 d.tex lyocell 10mm | 100 | 58 | 100 | 63 |
| | 1.7 d.tex lyocell 12mm | 100 | 59 | 100 | 80 |

Sample 5

| Fibre Type | MD | Tenacity | | |
|-------------------------|-----|----------|-----|-----|
| | | MD | CD | CD |
| | Dry | Wet | Dry | Wet |
| 5 1.7 d.tex lyocell 5mm | 100 | 72 | 100 | 116 |
| 1.4 d.tex lyocell 5mm | 100 | 120 | 100 | 119 |
| 1.7 d.tex viscose 5mm | 100 | 72 | 100 | 84 |

Sample 6

| Fibre Type | Overall Tenacity | |
|--------------------------|------------------|------|
| | Dry | Wet |
| (all viscose fibres) | | |
| 0.75 d.tex 4mm | 100 | 67% |
| 0.95 d.tex 4mm | 100 | 96% |
| 0.95 d.tex 6mm | 100 | 56% |
| 15 0.95 d.tex 8mm | 100 | 52% |
| 1.7 d.tex 5mm | 100 | 170% |
| 3.3 d.tex 6mm | 100 | 128% |
| trilobal 12mm(2.6 d.tex) | 100 | 74% |

Overall tenacity is given by $\sqrt{\frac{(MD^2 + CD^2)}{2}}$

20 It can be seen that the fibres in themselves have a lower wet strength than dry strength and this observed property is generally reflected in the comparative strength of nonwoven fabric prepared from these fibres.

It is, therefore, surprising that it is possible to produce
25 a nonwoven hydroentangled fabric which has a greater wet

strength than dry strength without the use of resin binders.

From the samples and test results it can be seen that hydroentangled fabric made from lyocell staple fibre having a decitex below 1.7 d.tex, and preferably 1.4 d.tex, has a
5 generally higher wet strength than dry strength. This is true for all fabrics made according to the Samples 3-5.

It can be seen from Sample 4 that the increase in staple fibre length is accompanied by a general fall off in wet strength of the fabric as compared with its dry strength.
10 This is also confirmed for viscose staple fibres as shown in Sample 6. An optimum staple fibre length is about 5 to 6 mm. It can also be seen from the results that viscose fibres having a decitex of about 1.7 and upwards to about 4.0 d.tex also show an increase in wet strength.

Claims

1. A hydroentangled nonwoven fabric comprising entangled man-made cellulose fibres bonded together solely by their entanglement, the fabric having a tenacity when wet which is
5 greater than its tenacity when dry.

2. A fabric according to claim 1, wherein the fibres are staple fibres having a length of from 5 to 6 mm.

3. A fabric according to claim 1 or 2, wherein the fibres are non-fibrillated lyocell.

10 4. A fabric according to claim 3, wherein the fibres have a decitex of between 0.1 and 1.7.

5. A fabric according to claim 1 or 2, wherein the fibre comprises viscose fibres.

6. A fabric according to claim 5, wherein the viscose fibre
15 has a decitex not exceeding 4.0 decitex.

7. A fabric according to any one of the preceding claims, wherein the fabric has an areal density of from 50 to 200 gm⁻².

8. A method of manufacturing a fabric according to any one
20 of claims 1 to 7, wherein a web of regenerated cellulose

staple fibres, each having a length of between 5 and 6 mm is passed on a belt under at least one high pressure water jet assembly arranged transversely of the belt, and the at least one of the jet assemblies has an operating pressure of 5 between 75 and 200 bar.

9. A method according to claim 8, wherein at least the final jet assembly has an operating pressure of 100 bar.

10. A method according to claim 8 or 9, wherein the web of regenerated cellulose fibres is a wet laid web having an 10 areal density of between 50 and 200 gm².



Application No: GB 9601725.6
Claims searched: 1-10

Examiner: Alexander Littlejohn
Date of search: 7 March 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK CI (Ed.O): D1R (RFH, RFZ, RGH, RGZ)
Int CI (Ed.6): D04H 1/44, 1/46
Other: Online: WPI

Documents considered to be relevant:

| Category | Identity of document and relevant passage | | Relevant to claims |
|----------|---|---|---------------------------|
| Y | EP0333228A2 | (Kimberly-Clark) see e.g. page 4 line 39 and page 15 line 32 | 8,9,10 |
| X,Y | EP0321237A2 | (Asahi Kasei) see whole document, especially page 2 line 58 and Example 3 on pages 9,10 | X:1-7 Y:8-10 |
| X,Y | EP0303528A1 | (James River) see whole document, e.g. page 3 lines 7-12 and page 4 lines 22-25 | X:1,3,4,5,6,7 Y:8,9,10 |
| X,Y | US2862251 | (Kalwaites) see whole document, e.g. column 4 lines 63-70 and column 19 lines 68-73 | X:1-7 Y:8-10 |

| | | | |
|---|---|---|--|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
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